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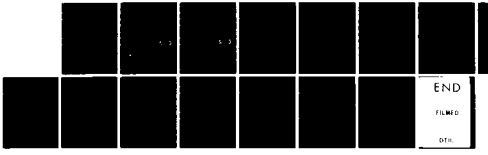

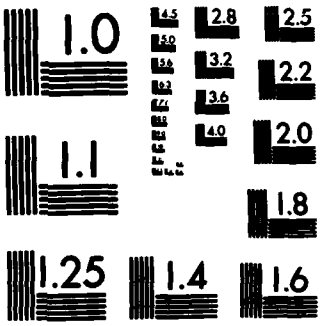

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DIFFERENCES IN HEALTH RISKS BY AIRCRAFT MODEL AMONG U.S. NAVY PILOTS

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Differences in Health Risks by Aircraft Model among U.S. Navy Pilots

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Summary

Problem

The need exists to determine whether or not health risks identified in a U.S. Navy pilot population can be attributed to the type of aircraft primarily flown. Concern also has been voiced about the possible long-term health effects associated with stressors unique to various aircraft models (e.g., G forces in fighter aircraft).

Objective

The objective of this study was to identify the health effects among U.S. Navy pilots who primarily flew one of eight different aircraft models. Comparisons of morbidity (hospitalization, medical board, and physical evaluation board) and mortality rates were conducted within two pilot subpopulations after dividing the total population at the 35-year age level for each of the eight aircraft models.

Approach

Information on the eight aircraft models, which was obtained from the Individual Flight Activity Reporting System (IFARS) file provided by the Naval Safety Center in Norfolk, consisted of total first pilot and copilot hours by model, birth year, and first year of flying for the pilot population from July 1967 through December 1979 (n = 22,245). Using data extracted from the officer career history file and the medical inpatient file, both of which are maintained at the Naval Health Research Center, annual hospitalization rates per 10,000 pilot strength were computed for 14 major diagnostic categories and several selected subcategories by model group for pilots older and younger than 35 years of age. Annual rates per 10,000 of medical boards, physical evaluation boards, and mortality also were computed for each of the eight model groups. Ninety-five percent confidence limits were computed to determine whether rates for each diagnosis differed significantly among aircraft models and between each group and the total pilot population.

Results

For each pilot group less than 36 years of age, the highest hospitalization rates were observed for either digestive disorders or accidental injuries. Younger pilots in the trainer/miscellaneous group had significantly higher hospitalization rates than all other groups for their total rate, accidental injuries, skin disorders, and musculoskeletal disorders. Significant differences also were obtained in comparisons of rates for five categories and four subcategories between trainer/miscellaneous pilots and at least four other aircraft groups. Younger helicopter pilots had significantly higher hospitalization rates for joint diseases than four other pilot groups and higher rates for nervous sytem disorders than two groups. Reconnaissance pilots were distinguished from others by lower total hospitalization rates. Comparisons of hospitalization and medical board rates between younger and older pilots reflected a shift with age to decreased injury rates and increased rates for circulatory diseases, mental disorders, and neoplasms.

Conclusions

Results of this study, particularly those for the trainer/miscellaneous and reconnaissance groups, reflected in part the effectiveness of the Navy's selection and retention procedures of continuously screening only the most healthy pilots into training programs and various aircraft

model assignments. The higher accidental injury rates among younger pilots in each tended to lend support for the correspondence between inexperience and accidental injuries; relatively few injuries, however, were attributable to an on-duty, aviation-related mishap. Results possibly associated with exposure to helicopter and fighter aircraft models only were suggested by the findings of this study. Another explanation for the low overall rates observed for each pilot group, except for trainer/miscellaneous pilots, as well as the few rate differentials obtained across groups was the exceptional health and physical fitness of Navy pilots. Also considered as a factor in explaining the relatively few rate differences across groups was the finding that many pilots had records of flight time in more than one of the eight categories, which would tend to dilute the significance of differences across groups.

Recommendations

Results of future research perhaps will substantiate the trends identified in this study. Findings of the present and future research can be used to form the basis for the development of prevention and intervention health care programs. The benefits to be accrued from these programs will be to further enhance and protect the health status of all military pilots.

Differences in Health Risks by Aircraft Model among U.S. Navy Pilots

Most research conducted on military aviators has concluded that, as a group, pilots are exceptionally healthy which clearly is a reflection of the stringent physical and mental standards established for selection and retention (17). When compared with civilians, Navy pilots are reported to have significantly lower hospitalization rates for most diseases (7). In studies of retired Navy pilots (the 1,000 aviator project), results show the mortality rate of a sample of Navy pilots who began training in 1940 to be considerably lower than that of their civilian counterparts (8).

While such findings underscore the excellent health status of military pilots, comparisons of Navy pilots' hospitalization rates with nonaviation officer groups revealed significantly higher rates among pilots for digestive diseases, accidental injuries, and musculoskeletal disorders as well as for the specific conditions of ischemic heart disease, Hodgkin's Disease, cancer of the testis, cardiac arrhythmia, effects of heat, and bone rarefaction (7). Age differences were evidenced in that the youngest pilots had the highest hospitalization rates for accidental injuries and disorders of tooth development and eruption while older pilots, particularly at ages 39-41, had the highest rates for circulatory diseases. An important conclusion of that study was the need to determine whether or not the health risks for several aviation-related disorders could be attributed to the type of aircraft model flown, especially for those pilots with a high level of hours flown in a specific model. The purpose of the present study was to identify the health effects among Navy pilots who primarily flew one of eight different aircraft models. Because reasons for hospitalizations differed across age groups, specifically above and below the age of 35 (7), comparisons of morbidity (hospitalization, medical board, and physical evaluation board) and mortality rates were conducted within two pilot subpopulations after dividing the total population at the 35-year age level for each of the eight aircraft models.

Background for this study centered on the serious concern that has been voiced about the possible long-term health effects associated with stressors unique to various aircraft models (3,5). Numerous articles, for example, have addressed the issue of the pilot's physiological limitations to withstand levels of increased G-forces of high performance aircraft, particularly among pilots with thousands of hours of exposure (16,18-22). Few studies, however, have identified the specific pathophysiologic effects of repeated high G exposures other than to show that the cardiovascular system is the most sensitive to high G conditions and the respiratory system is second in sensitivity.

In addition to high performance aircraft, other models have their own specific idiosyncrasies and, likewise, may adversely affect the health of individuals who fly them. Clinical studies have shown that helicopter pilots would have an increased probability of experiencing such effects of vibration and noise as lumbosacral pain, sciatica, trauma in joints and bone, visual acuity loss, and hearing loss (4,14,17). Other researchers (13) have suggested that the pilot's posture, which he or she is obliged to assume while operating a helicopter, contributes more to the incidence of

back pain than vibration. Helicopter pilots as well as pilots of aircraft models that are flown at low altitudes in hot climates or that have a limited cooling capacity (e.g., attack) also have an increased likelihood of suffering heat stress and the effects of dehydration (10). Aircraft models modified with electronic counter measures might subject the pilot to an increased risk of experiencing a radiation-related disorder (11). Pilots who fly sustained operations (e.g., helicopter or cargo/transport models) or who fly under adverse environmental conditions (e.g., flights through fog or storms) also experience greater demands on their physical and mental capabilities because of their increased workloads (2,12). This study, therefore, was designed to identify the extent of health risks associated with each of eight aircraft models: fighter, attack, electronic, helicopter, patrol/antisubmarine, cargo/transport, reconnaissance, and trainer/miscellaneous aircraft.

DATA AND METHODS

Study Population

The pilot population for this study was identified from the Individual Flight Activity Reporting System (IFARS) file which was provided to the Naval Health Research Center, San Diego by the Naval Safety Center in Norfolk, Virginia. This file consists of a summary historical record of each pilot's career flight activities as well as information pertinent to each aircraft model flown. To be included on this file, a pilot had to have served on active duty for any time period from July 1967 through December 1979; however, summary records of previous flying experience for those who flew prior to 1967 also were contained on the IFARS file.

Information on all aircraft models was compiled into individual pilot records (n = 22,245 men) consisting of a segment for each of 24 aircraft models (e.g., A-4, F-14); women pilots were excluded from this study because there were only 65. Included in each record were such variables as birth year, total first pilot and copilot hours, and initial year of flying as well as data specific to the 24 aircraft models (e.g., total pilot and copilot hours flown). The 24 specific models were condensed into eight general aircraft categories to ensure a more concise presentation of the results. Each pilot was classified, according to the highest total hours flown for one of the eight aircraft models, as primarily flying that type of aircraft. Numbers of pilots and mean hours flown for the eight models are presented in Table 1.

The aircraft model file was matched against the officer career history file and the medical inpatient file, both of which are chronological files maintained at the Naval Health Research Center. Data extracted from the officer career history file were date and reason for separation from active duty for those pilots who left the Navy during the July 1967 through December 1979 time period. Data selected from the medical inpatient file included pilot's age, date of each hospitalization, medical board, physical evaluation board, death record, and primary diagnosis [numeric codes were adapted from the International Classification of Diseases Adapted for Use in the United States (ICDA-8)]. (A medical board typically is convened to determine whether or not an individual should be returned to active duty whereas a physical evaluation board ascertains the extent of disability to be awarded.) Cause codes for each accidental injury and death also were obtained.

TABLE I. FREQUENCY DISTRIBUTION OF U.S. NAVY PILOTS, MEAN HOURS FLOWN, AND STANDARD DEVIATIONS BY AIRCRAFT MODEL TYPE, 1967-79.

Aircraft Model	No. of Pilots	Mean Hours Flown	SD
Cargo/Transport	1,238	3,055.9	2,012.2
Patrol/Antisubmarine	6,189	2,702.8	1,483.4
Electronic (electronically modified aircraft)	885	2,417.2	1,394.9
Attack (A-3, A-4, A-5, A-6, A-7, and all other attack)	3,854	2,376.5	1,430.4
Fighter (F-3, F-4, F-6, F-8, F-9, F-11, F-14, and all other fighter)	1,780	2,331.6	1,428.7
Helicopter (SH-3, UH-34, and all other helicopter)	3,267	1,964.6	1,246.7
Reconnaissance	193	1,725.1	1,208.0
Trainer/Miscellaneous	4,839	1,069.2	1,475.9

Procedure

The numbers of hospital admissions for each diagnosis during the 1967 through 1979 time period were tallied for pilots in the eight aircraft models after dividing the subgroups above and below the age of 35 years. Mean populations at risk were determined by calculating the numbers of pilots on active duty by calendar year, age, and aircraft model which then were averaged across the 12.5 years surveyed for this study. Using these mean populations at risk for each aircraft model by the two age intervals, annual hospitalization rates per 10,000 were computed for 14 major diagnostic categories and several selected subcategories for both age intervals by model subgroups. Although the numbers of medical board and physical evaluation board actions as well as deaths were quite small, rates per 10,000 were computed for each subgroup. Ninety-five percent confidence limits were computed to determine whether or not rates for each diagnosis differed significantly among aircraft models and between each group and the total pilot population. Only significant rate differences between a specific aircraft model and at least two other groups will be reported.

RESULTS

Hospitalization Rates by Model among Pilots less than 36 Years of Age

As shown in Table 2, the major diagnostic categories were rank ordered from highest to lowest hospitalization rates across aircraft models among pilots less than 36 years of age. Within each group, the highest rates were observed for either disorders of the digestive system or accidental injuries.

In comparing 95% confidence limits across groups and the total pilot population, the trainer/miscellaneous group was shown to have significantly higher hospitalization rates than all other groups for their total rate (628.2 per 10,000), accidental injuries, skin disorders, and musculoskeletal diseases (especially joint disorders, although the rate did not differ significantly from helicopter pilots). Pilots who primarily flew trainer/miscellaneous aircraft also had

TABLE II. ANNUAL HOSPITALIZATION RATES AMONG U.S. NAVY PILOTS (<36 YEARS OF AGE) BY DIAGNOSIS AND AIRCRAFT MODEL TYPE, 1967-79.

Diagnostic Category (ICDA-8)	Hospitalization Rates by Aircraft Model[a]								Overall rate
	Trainer/ Miscellaneous	Helicopter	Attack	Electronic	Cargo/ Transport	Fighter	Patrol/ Anti-Submarine	Reconnaissance	
Disorders of the Digestive System	173.5*	88.5*	62.5	84.6	33.4*	65.4	64.6	102.1	85.2
Disorders of tooth development	117.0*	44.0*	27.4	25.4	8.9*	26.8	27.3	68.1	43.4
Hernia	24.5	18.5	11.6	27.1	15.6	17.2	13.5	-	16.8
Ulcers	-	2.4	-	-	-	-	0.9	-	0.9
Accidents, Poisonings, and Violence	128.7*	75.3	73.7	60.9	82.5	86.9	55.8*	42.6	77.7
Fractures	33.2*	17.0	26.6	6.8	22.3	30.0	14.1*	-	21.2
Strains, sprains, dislocations	48.3*	27.5	23.6	18.6	26.7	34.3	18.2*	25.5	27.3
Diseases of the Musculoskeletal System and Connective Tissue	62.9*	38.3	30.0	35.5	15.6*	25.7	22.0*	-	33.4
Diseases of the joint	36.7*	23.2*	11.1	8.5	-	12.9	9.4*	-	16.4
Diseases of the back	6.4	8.5	11.1	15.2	-	5.4	7.2	0	8.2
Diseases of the Respiratory System	50.7*	29.3	24.8	18.6	20.1	21.4	22.3	42.6	28.2
Diseases of the Genitourinary System	24.5	23.7	25.7	25.4	37.9	13.9	25.1	0	24.2
Calculus of kidney and ureter	5.2	8.5	8.6	6.8	11.1	-	6.9	0	7.0
Infective and Parasitic Diseases	40.2*	17.0	23.6	23.7	33.4	19.3	21.0	-	24.0

Diseases of the Circulatory System	16.9	8.5	11.6	11.8	13.4	15.0	8.2	-	11.2
Cardiovascular disease	6.4	-	2.6	-	6.7	5.4	2.5	0	3.2
Symptomatic heart disease	1.7	-	1.3	-	6.7	4.3	0.9	0	1.7
Chronic ischemic heart disease	1.7	0	-	0	0	0	-	0	0.4
Hemorrhoids	4.1	3.8	5.1	-	-	3.2	1.9	0	3.3
Symptoms and Ill-defined Conditions	25.0*	9.5	12.8	11.8	11.1	24.7	8.8*	-	13.7
Diseases of the Skin and Subcutaneous Tissue	35.5*	15.6	10.3	13.5	13.4	13.9	13.2	-	16.5
Neoplasms	15.7	10.4	12.0	-	8.9	10.7	8.5	0	10.4
Leukemias and lymphomas	1.7	1.9	2.6	0	0	-	1.3	0	1.6
Mental Disorders	18.6*	3.8	6.4	8.5	6.7	3.2	7.5	0	7.9
Alcoholism	5.2	1.9	3.4	-	-	-	1.3	0	2.5
Supplementary Classifications	14.6	12.3	13.3	-	-	9.7	5.6*	-	10.0
Diseases of the Nervous System and Sense Organs	9.9	14.2*	3.9	11.8	13.4	7.5	4.7	0	8.0
Endocrine, Nutritional, and Metabolic Diseases	3.5	4.3	1.7	-	0	-	2.8	0	2.6
Hospitalization Rate	628.2*	356.0	315.6	319.7	296.4*	323.9	276.1*	255.3*	358.5
Mean Population at Risk	1,374	1,690	1,868	473	359	746	2,550	94	9,154

[a]Hospitalization rates are numbers of admissions per 10,000 population per year. Rates are not presented for diagnoses with a frequency less than 3. Because of low frequencies, rates for the categories of Congenital Anomalies and Diseases of the Blood and Blood-forming Organs are excluded as separate categories but are included in the overall hospitalization rates.

*Rate differs significantly ($p < .05$) from at least two other groups as determined by nonoverlapping confidence intervals.

significantly higher rates for digestive diseases (including disorders of tooth development and eruption), fractures, strains and dislocations, respiratory diseases, infective and parasitic diseases, symptoms and ill-defined conditions, and mental disorders; rates for each of these categories and subcategories differed significantly from rates for at least four other pilot groups. Comparisons of cause codes for this group's accidental injuries revealed that only 6.3% of the hospitalizations were attributable to an on-duty, aviation-related mishap; more than one-half (57.6%) of all accidental injury hospitalizations resulted as a consequence of a sports-related or a nonmilitary vehicular accident.

Other comparisons of confidence limits yielded few significant differences in hospitalization rates among aircraft models. Rates for helicopter pilots differed significantly from at least two other pilot groups, with higher values observed for digestive diseases, disorders of tooth development and eruption, joint diseases, and nervous system disorders. This group had the highest number of hospitalizations for the nervous system disorders of strabismus and ear and hearing problems; the numbers across groups, however, were too low to be included in the table. Pilots in the patrol/antisubmarine group had significantly lower hospitalization rates for accidental injuries (which included fractures and strains), musculoskeletal disorders, joint diseases, symptoms and ill-defined conditions, supplementary classifications, and all hospitalizations. Pilots who primarily flew cargo/transport models also had significantly lower hospitalization rates than several aircraft groups for digestive disorders (including tooth development and eruption conditions), musculoskeletal diseases, and all hospitalizations. The other aircraft model groups had fairly comparable hospitalization rates for most of the diagnostic categories and subcategories; differences in rates were nonsignificant across groups. Pilots in the reconnaissance group had so few hospitalizations (a total of 29) that rates for the majority of diagnoses could not be computed.

Hospitalization Rates by Model among Pilots 36 Years of Age and Older

In Table 3 are presented the hospitalization rates by diagnostic category and aircraft model among pilots 36 years of age and older. The rank ordering of hospitalization rates corresponds with Table 2 to enable the reader to readily compare rates between the two age groups. In contrast to Table 2, the rank ordering of rates by diagnosis and aircraft model differed in that the leading reasons for a hospitalization among older pilots included circulatory diseases for fighter pilots, musculoskeletal disorders among attack pilots, and digestive disorders for the other groups.

An examination of 95% confidence limits identified no specific aircraft model as having significantly higher hospitalization rates than all other models for any diagnostic category or subcategory. Reconnaissance pilots had significantly lower total hospitalizations than all other groups except electronics. Only two other comparisons yielded significant results: helicopter pilots had significantly higher hospitalization rates than attack and fighter pilots for digestive disorders while fighter pilots had significantly lower rates for hernias. The percentage of on-duty, aviation-related injuries among attack pilots, although relatively low at 12.5%, was one of the highest across the eight groups.

TABLE III. ANNUAL HOSPITALIZATION RATES AMONG U.S. NAVY PILOTS (≥36 YEARS OF AGE) BY DIAGNOSIS AND AIRCRAFT MODEL TYPE, 1967-79.

Diagnostic Category (ICDA-8)	Hospitalization Rates by Aircraft Model[a]								Overall Rate
	Trainer/ Miscellaneous	Helicopter	Attack	Electronic	Cargo/ Transport	Fighter	Patrol/ Anti-Submarine	Reconnaissance	
Disorders of the Digestive System	69.9	97.6*	52.3	64.6	76.4	40.7	66.2	0	64.1
Disorders of tooth development	0	-	-	0	0	-	-	0	1.3
Hernia	45.9	32.5	25.1	32.3	22.9	12.4*	33.7	0	29.2
Ulcers	-	13.0	-	-	12.7	5.3	4.8	-	5.4
Accidents, Poisonings, and Violence	30.6	41.2	50.2	40.4	17.8	35.4	29.5	-	35.0
Fractures	15.3	10.8	20.9	-	7.6	23.0	10.8	-	14.4
Strains, sprains, dislocations	6.6	15.2	12.5	-	10.2	-	9.6	0	9.7
Diseases of the Musculoskeletal System and Connective Tissue	41.5	26.0	54.4	40.4	45.9	37.2	36.7	0	40.4
Diseases of the joint	-	-	14.6	-	15.3	12.4	5.4	0	8.8
Diseases of the back	17.5	17.3	25.1	-	17.8	12.4	18.0	0	18.5
Diseases of the Respiratory System	19.7	26.0	13.6	-	15.3	12.4	18.6	0	17.2
Diseases of the Genitourinary System	35.0	34.7	33.5	-	25.5	23.0	24.1	0	27.5
Calculus of kidney and ureter	13.1	23.8	13.6	0	10.2	-	6.6	0	9.9
Infective and Parasitic Diseases	15.3	10.8	19.9	0	20.4	19.5	6.6	0	13.1

Diseases of the Circulatory System	35.0	54.2	36.6	48.5	53.5	60.2	39.7	-	43.9
Cardiovascular disease	15.3	19.5	16.7	24.2	15.3	28.3	23.5	0	20.6
Symptomatic heart disease	-	6.5	-	0	-	-	4.2	0	3.4
Chronic ischemic heart disease	-	-	6.3	24.2	0	15.9	10.2	0	8.4
Hemorrhoids	15.3	10.8	10.5	-	20.4	17.7	10.8	-	12.9
Symptoms and Ill-defined Conditions	17.5	21.7	11.5	24.2	20.4	12.4	21.7	0	17.8
Diseases of the Skin and Subcutaneous Tissue	-	6.5	4.2	0	-	8.8	4.8	-	5.4
Neoplasms	10.9	21.7	15.7	24.2	15.3	14.2	16.8	0	16.1
Leukemias and lymphomas	0	0	0	0	0	-	-	0	0.9
Mental Disorders	21.9	26.0	16.7	-	10.2	14.2	26.5	-	20.8
Alcoholism	15.3	19.5	14.6	0	-	5.3	16.8	0	13.5
Supplementary Classifications	15.3	15.2	15.7	-	-	14.2	13.8	0	13.8
Diseases of the Nervous System and Sense Organs	10.9	17.3	24.1	-	-	10.6	17.4	0	16.1
Endocrine, Nutritional, and Metabolic Diseases	-	0	4.2	0	-	7.1	5.4	0	4.3
Hospitalization Rate	336.6	401.1	354.5	315.2	323.6	309.7	331.4	123.1*	338.4
Mean Population at Risk	366	369	765	99	314	452	1,330	26	3,721

Hospitalization rates are numbers of admissions per 10,000 population per year. Rates are not presented for diagnoses with a frequency less than 3. Because of low frequencies, rates for the categories of Congenital Anomalies and Diseases of the Blood and Blood-forming Organs are excluded as separate categories but are included in the overall hospitalization rates.

*Rate differs significantly ($p < .05$) from at least two other groups as determined by nonoverlapping confidence intervals.

Other comparisons showed that overall differences between younger and older pilots were minimal: 358.5 versus 338.4, respectively. Several shifts, however, were observed in that rates for the accidental injury category declined substantially between younger and older pilots as did rates for respiratory diseases, skin disorders, and infective and parasitic diseases. Digestive disorder hospitalization rates between groups showed marked fluctuations whereby a decrease in hospitalizations for tooth development problems was evidenced as well as an overall increase in admissions for hernias, intestinal disorders, and ulcers. For example, rates of ulcer hospitalizations were considerably higher for older than younger pilots in the helicopter and cargo/transport groups. The largest differentials between the two age groups were noted by increases in rates for circulatory diseases and mental disorders (especially alcoholism).

Medical Boards, Physical Evaluation Boards, and Deaths by Model

Among pilots less than 36 years of age, medical board rates per 10,000 ranged from 21.0 for patrol/antisubmarine pilots to 50.1 for trainer/miscellaneous pilots. The highest rates for each aircraft model were for either accidental injuries or musculoskeletal disorders (primarily joint and back disorders). The third-ranked diagnostic category, although at considerably lower rates than the two leading reasons, was neoplasms, of which Hodgkin's Disease and cancer of the testis were the most prevalent diagnoses. Neuroses and sarcoidosis, with low frequencies across models, occupied the fourth- and fifth-ranked positions.

Pilots 36 years of age and older showed somewhat higher overall medical board rates than younger pilots, values that fell within a range from 17.8 per 10,000 strength for cargo/transport pilots to 77.9 for fighter pilots. Diseases of the circulatory system was the category with the highest number of medical board actions across the eight models; fighter pilots had the highest rate for these disorders. The second-ranked category was musculoskeletal conditions followed by accidental injuries and neoplasms.

Numbers of physical evaluation board actions differed from medical boards in that there not only were considerably fewer such records (610 versus 202) but the reasons differed as well. The major diagnostic categories reviewed by a physical evaluation board included musculoskeletal disorders, neoplasms, and mental disorders among younger pilots and musculoskeletal disorders, circulatory diseases, and neoplasms among older pilots. The most important difference between younger and older pilots was the increased risk of a circulatory disease board action among older pilots.

Comparisons of the death data for both age subpopulations were limited by the fact that information on the cause of death was available only for the 1974 to 1979 time period. Using data for this time frame, younger pilots had a higher rate of on-duty, aviation-related deaths (17.8 per 10,000) than older pilots (6.2). Sixty-two percent of all recorded deaths were on-duty, avaition related; younger attack pilots had the highest mortality rate for these injuries. Other reasons included, in order of frequency, "unknown" causes, all other accidents, cardiovascular disease, and cancer. It should be noted that only 10 deaths were attributed to cardiovascular disease and cancer.

DISCUSSION

Results of this study identified several health risks postulated as related to piloting a particular aircraft model group. The most clear-cut findings across pilot groups were the numerous significantly higher hospitalization rates for younger trainer/miscellaneous aircraft pilots whereas fewer significant differences were evidenced for the helicopter, reconnaissance, cargo/transport, and patrol/antisubmarine pilot groups. Explanations for these findings may be provided by examining the influence of such considerations as 1) selection and retention; 2) age, experience, and exposure; 3) population characteristics; and 4) aircraft model assignments.

First, results of this research reflected in part the effectiveness of the Navy's selection and retention procedures of continuously screening only the most healthy pilots into training programs and various aircraft model assignments. Men in the trainer/miscellaneous group, for example, were distinguished from all other pilot groups by their higher rates for the four diagnostic categories of digestive disorders, accidental injuries, musculoskeletal diseases, and skin disorders. Their total hospitalization rate as well as rates for five categories and four subcategories were significantly higher than at least two other pilot groups. Only five of the 14 major diagnostic categories failed to yield statistically significant rate differences. These findings suggested that pilots transitioning from trainers to any of the other models would not be so assigned unless they were in excellent physical and mental condition. Many hospitalizations, therefore, might have been prescribed in an effort to ensure the safety and excellent health of the pilot throughout the training phase and during subsequent assignments. A specific example would be the high rate observed among trainer/miscellaneous pilots for disorders of tooth development and eruption.

Pilots who primarily flew reconnaissance aircraft, on the other hand, were distinguished from other pilots by their exceptionally low overall hospitalization rates. Qualifying as a pilot of reconnaissance aircraft no doubt involved even more stringent physical and mental standards than those established for becoming a pilot, which in all likelihood accounted for at least a portion of their very low hospitalization rate.

Second, with regard to age, experience, and exposure, accidental injuries represented a large proportion of the total hospitalization and medical board rates for each younger pilot group. The vast majority of these injuries (more than 85%) had a code identifying the underlying cause as unrelated to aviation. For example, although younger pilots in the trainer/miscellaneous group had the highest rate of accidental injuries, only 6.3% of these injuries were attributable to an on-duty, aviation-related mishap; injuries associated with an athletic or vehicular accident accounted for the largest proportion of their injury rate. The highest percentage of on-duty, aviation-related injuries were observed for attack pilots, 14.0% for younger and 12.5% for older pilots. Other age-related results indicated that on-duty, aviation-related injuries among younger pilots represented the majority of recorded deaths. In addition to the relationship of age with accidental death, inexperience also was shown to be associated with a higher mortality rate: among young attack pilots who died in an aviation-related mishap, their mean hours flown was less than 500 hours. In general, these findings underscored the well-known correspondence between

inexperience and accidental injuries (3,5,9), particularly among attack pilots (1). Comparisons of hospitalization and medical board rates between younger and older pilots reflected quite clearly a shift with age to decreased injury rates and increased rates for diseases of the circulatory system, mental disorders (primarily alcoholism), and neoplasms.

Other results possibly associated with experience and exposure were the significantly higher hospitalization rates for joint diseases and nervous system disorders among younger helicopter pilots. Characteristics inherent to helicopters, such as vibration, noise, and periods of sustained flying time, might account for these increased health risks. Although these findings lent support for the research cited at the outset (4,10,14,17), the obtained significant differences between helicopter pilots and at least two other pilot groups perhaps should be interpreted more as trends rather than as distinguishing health risks because of the relatively few significant results observed. Back disorders, moreover, were not determined to be an increased risk among helicopter pilots in this study, as had been hypothesized.

Also to be considered as potentially related to exposure was the result that the highest hospitalization rate among older fighter pilots was for diseases of the circulatory system although this value was not significantly higher than other pilot groups. Several researchers (c.f., 5,16) have cautioned that repeated exposure to high sustained G forces might contribute to a higher than expected rate of cardiovascular disease. In order to understand the potential pathological effects of sustained G loading, Hickman et al. (5) recommended that a repository "should be established to maintain all medical examinations, including specialized tests on aviators who are flying or who have flown high-performance aircraft." With such a research source, prospective studies could be conducted to accurately identify the long-term health effects associated with various fighter models as well as other aircraft. As an initial step in this direction, a longitudinal study (6) recently was completed which examined in depth the hospitalization, board appearance, and flight records of the 150 pilots in the present population who were diagnosed with cardiovascular disease. Although results of comparisons of cardiovascular disease incidence did not significantly differentiate fighter pilots from other aircraft groups, their rates were the highest for acute myocardial infarction and chronic ischemic heart disease. Because the number of fighter pilots was so small, one recommendation was to replicate that study on a much larger population, possibly including U.S.A.F. high performance aircraft pilots.

The third consideration centered on the influence of such characteristics as the exceptional health and physical fitness of the pilot population. Not only were there few differences in rates across all groups, except trainer/miscellaneous pilots, but numbers of hospitalizations, medical board appearances, and physical evaluation board actions observed in this study were quite low. For example, in a population of 6,189 patrol/antisubmarine pilots, only 51 men were diagnosed with cardiovascular disease during 12.5 years. Because the events under study were rarely occurring, the range of the 95% confidence limits for each group typically was quite wide and, therefore, overlapped with other intervals to yield nonsignificant differences. As a consequence, health risks were not shown to be highly related to a specific aircraft model other than trainer/miscellaneous aircraft. Further, the significantly lower rates for pilots in the cargo/transport and

patrol/antisubmarine groups tended to be mirror images of the significantly higher rates observed for the trainer/miscellaneous pilot group.

The fourth consideration was associated with the issue of aircraft model assignments. An examination of the IFARS file revealed that many pilots had records of flight time in more than one of the eight categories, which would tend to dilute the significance of differences across groups. Aviation researchers in the future probably will not have to contend with this operational factor because with the increasingly greater technological advances of the newer aircraft models, the "fly one, fly all" policy will change to the more restrictive categorical flying (5).

Results of future research perhaps will substantiate the trends identified in of this study. Findings of the present and future research can be used to form the basis for the development of prevention and intervention health care programs. The benefits to be accrued from these programs will be to further enhance and protect the health status of all military pilots.

REFERENCES

1. Borowsky, M. S., and R. Wall. Flight experience and naval aircraft mishaps. Aviat. Space Environ. Med. 54:440-446, 1983.
2. Borowsky, M. S., and R. Wall. Naval aviation mishaps and fatigue. Aviat. Space Environ. Med. 54:535-538, 1983.
3. Burton, R. R. Human responses to repeated high G simulated serial combat maneuvers. Aviat. Space Environ. Med. 51:1185-1192, 1980.
4. Dowd, P. J., and F. H. Brunstetter. Crew stress and fatigue in the Pave Low III system. Report SAM-TR-80-26. Brooks Air Force Base, TX: USAF School of Aerospace Medicine; 1980.
5. Hickman, J. R., J. H. Triebwasser, and M. C. Lancaster. Physical standards for high-performance fighter aircraft pilots. Aviat. Space Environ. Med. 51:1052-1056, 1980.
6. Hoiberg, A. Cardiovascular disease among U.S. Navy pilots. Report No. 84-27. San Diego, CA: Naval Health Research Center; 1984.
7. Hoiberg, A., and C. Blood. Age-specific morbidity among Navy pilots. Aviat. Space Environ. Med. 54: 912-918, 1983.
8. MacIntyre, N. R., R. E. Mitchell, A. Oberman, W. R. Harlan, A. Graybiel, and E. Johnson. Longevity in military pilots: 37-year followup of the Navy's "1000 Aviators." Aviat. Space Environ. Med. 49:1120-1122, 1978.
9. Mason, J. K. Previous disease in aircrew killed in flying accidents. Aviat. Space Environ. Med. 48:944-948, 1977.
10. Munneley, S. A., and C. F. Flick. Heat stress in the A-10 cockpit: Flight over desert. Aviat. Space Environ. Med. 52:513-516, 1981.

11. Robinette, C. D., C. Silverman, and S. Jablon. Effects upon health of occupational exposure to microwave radiation (radar). Am. J. Epidemiol. 112:39-53, 1980.

12. Roscoe, A. H. Stress and workload in pilots. Aviat. Space Environ. Med. 49:630-636, 1978.

13. Shanahan, D. F., and T. E. Reading. Helicopter pilot back pain: A preliminary study. Aviat. Space Environ. Med. 55:117-121, 1984.

14. Stave, A. M. The influence of low frequency vibration on pilot performance (as measured in a fixed base simulator). Ergonomics. 22:823-835, 1979.

15. Ursano, R. J. Stress and adaption: The interaction of the pilot personality and disease. Aviat. Space Environ. Med. 51:1245-1249, 1980.

16. Voge, V. M. Acceleration forces on the human subject. Aviat. Space Environ. Med. 51:970-980, 1980.

17. Voge, V. M. Role of pre-existing disease in the causation of naval aircraft mishaps. Aviat. Space Environ. Med. 52:677-682, 1981.

18. Whinnery, J. E. Acceleration stress-induced Wolff-Parkinson-White Syndrome with marked ST-segment depression. Aviat. Space Environ. Med. 52:654-657, 1981.

19. Whinnery, J. E. Acceleration-induced atrioventricular dissociation: Hemodynamic consequences. Aviat. Space Environ. Med. 53:432-434, 1982.

20. Whinnery, J. E. Post-acceleration chaotic atrial rhythm. Aviat. Space Envrion. Med. 53:390-392, 1982.

21. Whinnery, J.E., and R.M. Shaffstall. Incapacitation time for +G - induced loss of consciousness. Aviat. Space Environ. Med. 50:83-85, 1979.

22. Whinnery, J. E., M. H. Laughlin, and G. S. Uhl. Coincident loss of consciousness and ventricular tachycardia during +G stress. Aviat. Space Environ. Med. 51:827-831, 1980.

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The purpose of this study was to identify health risks associated with eight aircraft models in a population of U.S. Navy pilots (n = 22,245) during a 12.5-year time period. Results showed that pilots in the trainer/ miscellaneous group ($\leq$ 35 years of age) had significantly higher hospitalization rates than other pilot groups for almost all diagnoses whereas reconnaissance pilots were distinguished from others by lower total hospitalization rates. Younger helicopter pilots had significantly higher hospitaliza-

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tion rates for joint diseases than four other pilot groups and significantly higher rates for nervous system disorders than attack and patrol/antisubmarine groups. Explanations for these and mortality rate results were provided by examining the influence of selection and retention criteria; age, experience, and exposure; pilot population characteristics; and aircraft model assignments.

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